

INVESTIGATOR'S ANNUAL REPORT

National Park Service

All or some of the information provided may be available to the public

Reporting Year: 2004	Park: Shenandoah NP						
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Permit#: SHEN-1999-SCI-0002							
Park-assigned Study Id. #: SHEN-00277							
Project Title: Characterization of Metamorphism and Tectonic Setting of Grenvillian Rocks in the Western Blue Ridge, Virginia							
Permit Start Date: Sep 01, 1999	Permit Expiration Date May 31, 2004						
Study Start Date: Sep 01, 1999	Study End Date May 31, 2005						
Study Status: Completed							
Activity Type: Research							
Subject/Discipline: Geology / General							
Objectives: <p>Grenville-age rocks in the western Blue Ridge terrane in Virginia consist of a layered metamorphic sequence, characterized by granulite-facies mineral assemblages, intruded by charnockite (two-pyroxene granite) and anorthosite plutons. This plutonic-metamorphic terrane constitutes the former rifted Laurentian margin of North America, much modified during Paleozoic orogenic events. Other than basic lithologic descriptions and some geochronology, relatively little is known about the metamorphic basement rocks into which Grenvillian plutons were intruded. The depths of intrusion of the charnockites and anorthosites are unknown and the timing of intrusion relative to granulite metamorphism is poorly constrained, although granulite-facies metamorphism in northern Appalachian Grenville terranes is known to postdate the intrusions. Emplacement of such plutons is believed to have occurred at shallow depths (5-10 km) and low pressures (2-3 kbars), however, arguments have been made, based on the presence of Fe-rich orthopyroxenes in charnockites, that some of these plutons might have been emplaced at significantly greater depths (e.g. Ollila et al., 1988, American Mineralogist).</p> <p>At present, systematic variation in the tectonic setting of Grenvillian terranes from different parts of the Appalachians has not been documented. This proposed study will address this by investigating the interactions of Grenvillian plutons with metamorphic basement through the use of petrologic, thermobarometric, and geochronologic techniques in order to better constrain the tectonic and metamorphic histories of the western Virginia Blue Ridge and to document any significant differences from other Grenvillian terranes within the Appalachians.</p> <p>The goals of this project are to produce: (1) a detailed characterization of western Blue Ridge basement lithologies, (2) a quantitative evaluation of the metamorphic processes that have affected these lithologies, and (3) a determination of the extent and nature of interaction of these rocks with Grenvillian plutons. Detailed mapping and petrographic observations will be used to search for evidence of preserved contact aureoles around Grenvillian intrusions. Intrusion of charnockites and anorthosites into rocks at lower than granulite-facies grade would have produced high-T (potentially 800-1000 C) metamorphic assemblages in contact aureoles that should not have been completely overprinted by a later, somewhat lower-grade (700-800 C), regional granulite-facies event. Even if the basement had already experienced a high-grade (granulite-facies) event prior to intrusion and obvious contact aureoles were not formed, some observable textural and mineral-chemical modifications would have occurred adjacent to igneous</p>							

contacts. The primary analytical technique to be employed in this study will be electron microprobe analysis, for (1) acquiring chemical data to be used for P-T estimations by published thermobarometric techniques, and (2) dating metamorphic and igneous monazites using trace-element analyses of U, Th, and Pb in an exciting new technique for microprobe-based geochronology. This method has advantages over geochronology by traditional U-Pb mass spectrometry because it allows for the resolution of multiple metamorphic events that may have been preserved in narrow zones within individual monazite crystals.

This project ultimately should produce results that are useful at two scales. Preserved contact aureoles documented by paleothermal or petrographic evidence will be used, along with geochronologic and geobarometric data, to constrain crustal depths, timing, and the nature of country rocks in the Proterozoic intrusive event. In addition, thin-section scale observations of the contact zones will provide valuable information on mid- and deep-crustal intrusive and metamorphic mechanisms.

Findings and Status:

The symplectic nature of garnet and biotite in granulites and charnockites was investigated. Pressure and temperature conditions were estimated using Garnet-Biotite and Al-in-Orthopyroxene with Garnet geothermobarometers.

Garnet and Biotite occur in two forms in these rocks, early porphyroblasts and late symplectites.

Garnet and Biotite symplectites formed as a result of the breakdown of Orthopyroxene through the reactions:

1) $6 \text{ Opx} + 3 \text{ Plag} \rightarrow 2 \text{ Grt (Alm,Pyr)} + \text{Grt (Gros)} + 3 \text{ Qtz}$

2) $3 \text{ Opx} + \text{K-feld} + \text{Water} \rightarrow \text{Biot} + 3 \text{ Qtz}$.

P-T estimates gave a broad range of conditions ranging from over 800 C and over 8 kbars to below 500 C and below 5 kbars. Many of these estimates fall below the stability field of orthopyroxene (below granulite-facies metamorphic conditions).

The lower temperatures and wide ranges of temperatures are attributed to:

1) The use of mineral phases that are out of equilibrium for temperature calculations. Biotite porphyroblasts break down at a lower temperature than orthopyroxene and form late garnet and K-feldspar.

2) Continual resetting of mineral compositions to lower metamorphic grades (greenschist- and amphibolite-facies).

For this study, were one or more specimens collected and removed from the park but not destroyed during analyses?

Yes

Funding provided this reporting year by NPS:

0

Funding provided this reporting year by other sources:

0

Fill out the following ONLY IF the National Park Service supported this project in this reporting year by providing money to a university or college

Full name of college or university:

n/a

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